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DESCRIPTION

"NON-WOVEN BASED ON EXPLODED OR SPLITTABLE MULTI-COMPONENT FIBERS"

FIELD OF THE INVENTION

[0001]. The present invention relates to the field of multi-layer non-wovens, which can be used as an absorbent material, particularly in the field of surface cleaning, personal hygiene or for the formation of garments.

BACKGROUND OF THE ART

[0002]. A non-woven is widely used as a replacement for traditional textile products in a number of sectors, for example in the field of cleaning and protection of surfaces, or in the production of garments. Compared to traditional fabrics, the non-woven have the advantage of lower production costs, outstanding mechanical properties and a high biocompatibility with skin.

[0003]. Non-wovens are formed by synthetic, natural or naturally-derived material fibers, which are arranged on a mat in a molten state and left to solidify in the form of a layer; the thus obtained structure can be consolidated by dynamic treatments such as point-bonding or calendering or by water jets (hydro-entangling); other prior art bonding processes are mechanic needling, thermobonding, chemical bonding, etc.

[0004]. Non-woven fibers generally consist of a single

component; however for particular applications they may also be produced in a multi-component form, through the joint extrusion of different polymers.

[0005]. The non-woven fibers are used in the form of single-ply or in the form of multi-layer composites; of the multi-layer composites those containing one or more layers of non-woven, associated to a layer of cellulose fibers are known: in these cases the final composite advantageously combines the non-woven mechanical properties to the absorbent properties of cellulose fibers.

[0006]. Unfortunately, the manufacture of these composites entails particular problems: in fact, the cellulose layer (that is typically formed by short fibers and is poorly reactive to the entangling processes), is very mobile and poorly cohesive with the other layers; therefore problems of cellulose material loss during the formation of the multi-layer composite are frequent, thus requiring to increase the amount of cellulose fibers used to compensate the losses; besides in the final composite one encounters problems of migration of the cellulose fibers thus creating areas that are richer and areas that are poorer in pulp inside the multi-layer non-woven and excessive pulp loss during hydro-entangling. In addition the cases of composite delamination due to

insufficient entangling between the different layers and between the continuous thread fibers on the outer surfaces are frequent. In other words, the continuous thread fibers of each of the outer layers of non-woven do not entangle suitably either with one another or with the fibers of different layers but rather they protrude from the respective outer surfaces in the form of tiny slots. In this way, when a non-woven sheet comes into contact with a rough surface such as a person's hand, the non-woven tends to stick in a bothersome way to the rough surface due to miniscule contacts between said slots and the ribs of the rough surface.

[0007]. In order to resolve these problems, US patent 5,587,225 (Griesbach et al.) discloses a composite formed by a cellulose layer interposed between two outer non-woven layers, in which the non-woven fibers are not smooth, but have a series of creases or "crimps" per unit length of the fiber. The outer layers are then made integral with the cellulose layer by hydro-entangling, and final fixing of the 3 layers made adhesively or thermally (calendering). In any case, the crimping and creasing processes make the composite preparation process longer and more expensive, and they considerably reduce the softness of the product.

[0008]. WO-A-01/63032 (Orlandi-Fleissner) discloses a

multi-layer cellulose/non-woven composite wherein the layer of non-woven is carded and pre-consolidated separately by means of calendering. The different layers of the composite are thus overlapped and entangled by means of hydro-entangling. Also in this case it is necessary to resort to additional processes of non-woven calendering and pre-consolidation in order to obtain a multi-layer composite with acceptable performance, and limit the loss of pulp during hydro-entangling.

[0009]. Common to all the solutions proposed is the need to perform many adhesion processes and/or pre-treatment of the fibers in order to obtain a sufficiently cohesive multi-layer product: this entails an increase in process time and costs and moreover an excessive rigidity of the final product when additional thermo-welding processes are followed.

SUMMARY

[0010]. The object of the present invention is therefore to overcome all the inconveniences mentioned with reference to the multi-layer non-wovens obtained according to the state of the art and particularly according to the processes described above.

[0011]. This object is achieved by a process for preparing a single- or multi-layer non-woven and a thus obtained single- or multi-layer non-woven, as detailed in

the independent claims appended hereto.

[0012]. It was surprisingly noted that the use of particular polymer fibers for the formation of the outer layers of single-layer non-woven allows to resolve the abovementioned drawbacks and advantageously improve the functional and tactile characteristics of the product itself.

[0013]. Particularly, the single- or multi-layer non-woven fabric is of a hydro-entangled type based on exploded continuous thread or splittable multi-component continuous thread fibers. The thus obtained fabric has for example high characteristics of softness and resilience.

[0014]. By "continuous thread fibers " is meant herein a single continuous fiber composed of one or more synthetic or natural polymer components that may be decomposed into single micro-fibers, or filaments, according to the type of fiber used. Accordingly, both the splittable multi-component polymer fibers and the exploded polymer fibers give origin to micro-fibers, which are thinner than the fibers from which they derive.

DESCRIPTION OF THE FIGURES

[0015]. Further characteristics and the advantages of the non-woven in accordance with the present invention will be better understood in the following detailed

description of embodiments provided by way of non-limiting examples with reference to the appended figures, wherein:

- Figure 1A represents a schematic view of the production line and of the manufacturing steps of the single-layer non-woven;

- Figure 1B represents a schematic view of the production line and the manufacturing steps of three-layer non-woven composite according to the present invention;

- Figure 1C represents a schematic view of the production line and the manufacturing steps of a three-layer non-woven composite with pre-hydro-entangling of one layer according to the present invention;

- Figure 2 represents a perspective view of two embodiments of the mat on which the fibers according to the present invention are arranged;

- Figure 3 represents a microscope image of a polymer fiber before (3a) and after (3b) the treatment according to the process described in patent application WO 00/20178 in the name of Hills, Inc and Fiber Innovation Technology, Inc.;

- Figure 4A represents a microscope image of the polymer fiber obtained with Nanoval technology comprising polypropylene and Fluff Pulp described in patent application WO 02/052070;

- Figure 4B represents a microscope image of the spun-bond type polymer fiber with a diameter of 2.2 dtex of the continuous thread type and 80 g/mt^2 PES weight;

- Figure 4C represents a microscope image of the polypropylene polymer fiber obtained with Nanoval technology according to the patent application WO 02/052070;

- Figure 4D represents a microscope image of the polymer fiber obtained with Nanoval technology according to patent application WO 02/052070 with different process parameters that determine a different "explosion" effect, according to one variant of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0016]. A first object of the present invention is therefore to provide a process for the production of a single- or multi-layer hydro-entangled non-woven comprising exploded fibers or splittable multi-component fibers.

[0017]. A second object of the present invention is a hydro-entangled single- or multi-layer non-woven, based on exploded fibers or based on splittable multi-component fibers.

[0018]. The fiber forming the non-wovens of the present invention is a continuous fiber and is generally produced by three technologies:

a. production of bi-component synthetic polymer fibers (multisegments), that are can be split with a hydro-entangling machine;

b. production of synthetic polymer fibers with explosion effect, for example polyester, polypropylene, polyethylene (technology known as "Nanoval" described in patent applications WO-A-02052070 and DE-A-19929709, incorporated herein for reference);

c. production of natural fibers with explosion (such as Lyocell, PLA, etc.) by "Nanoval" technology described above.

<u>1. Production of splittable synthetic polymer fibers</u>

[0019]. As for the production of a single layer, as represented schematically in figure 1A, the manufacturing steps generally comprise the supply of the non-woven layer T_1 in the form of fibers by means of a spinneret 1 (extruder) coupled up to a conventional suction fan A, a hydro-entangling station 2, a drying station 3 and a rewinding station 4 of the hydro-entangled layer into a roll. For the details of each step, reference should be made to the following description with reference to figures 1B and 1C in which the steps with similar names are identical to those outlined above.

[0020]. The process for the production of a non-woven, comprises the following manufacturing steps;

a) preparing at least one layer (T_1) of splittable multi-component polymer fibers;

b) hydro-entangling said at least one layer such as to obtain a non-woven in which the multi-component polymer fibers are split into mono-component micro-fibers that entangle with one another.

[0021]. According to one embodiment of the present invention, the process provides that step a) comprises:

- preparing at least one layer (T_1) of splittable multi-component polymer fibers;
- laying at least one layer of absorbent material fibers (T_3) on said at least one layer (T_1),

whereby the hydro-entangling step b) takes place such as to obtain a non-woven in which the multi-component polymer fibers split into mono-component micro-fibers entangling with one another and with the fibers of the absorbent material.

[0022]. The production of a multi-layer composite in accordance with the present invention (figure 1B) generally provides, on the other hand, the supplying of the first layer of non-woven T_1 by means of a special spinneret 5, one or more stations 6 for the laying of cellulose pulp 60, the laying of a second layer of non-woven fabric T_2 by means of a special spinneret 7, hydro-

entangling 8, drying 9 and rewinding 10.

[0023]. Referring to a multi-layer product, it is widely known that splittable multi-component fibers may be produced through extrusion by spinnerets of polymer materials such as to form continuous fibers, in accordance with the technology a. identified above. These fibers when exiting from the spinnerets are hit by a jet of compressed air that causes the elongation and the electrostatic charging thereof such to cause a mutual repulsion causing them to fall randomly onto a conveyor belt.

[0024]. With reference to figure 1B, a process for the production of multi-layer non-woven fabric comprising outer layers made with splittable fibers according to the abovementioned technology will now be described. In any case, the subject process comprises the following manufacturing steps:

- preparing at least one first layer T_1 of splittable multi-component polymer fibers (corresponding to step a) as described above);
- laying on said at least one first layer T_1 at least one layer T_3 of fibers of absorbent material 60;
- laying at least one second layer T_2 of splittable multi-component polymer fibers on said at least one layer of fibers of absorbent material 60;

- hydro-entangling the layers of fibers obtained after the abovementioned steps such as to obtain a multi-layer non-woven in which the multi-component polymer fibers are split into individual mono-component micro-fibers that entangle with one another and with the fibers of the absorbent material (corresponding to step b) as described above).

[0025]. Particularly, splittable multi-component synthetic fibers may be formed for the separate extrusion of the individual polymers in a molten state in the form of threads 50, 70 that protrude from orifices, of capillary dimensions, of a spinneret 5, 7 and the union thereof below the spinneret. The polymers at the molten state are linked in a single fiber combined by extrusion of the individual polymer threads in directions such as to cause the contact thereof and the adhesion thereof, as described in patent US 6,627,025. A suction fan A positioned below the spinneret has the function of sucking and conveying the individual threads of extruded polymer in order to favour the bonding thereof into a single fiber.

[0026]. The synthetic fibers may be composed of at least two threads of a single polymer up to 16 threads of different polymers, be they homopolymers, copolymers or mixtures thereof. The polymers may be selected from

polyesters, polyamides, polyolefins, polyurethane, polyester modified with additives, polypropylene, polyethylene, polypropylene terephthalate, polybutylene terephthalate.

[0027]. Preferably, such polymers may be selected such that in the fibers adjacent polymers cannot mix or in any case have poor affinity in order to favour the subsequent separation thereof. Alternatively, the polymers may be additized with lubricants that prevent the adhesion thereof. In addition, as the longitudinal, axial portion of the fiber usually has a greater force of cohesion than the peripheral portion, it may be advantageous to spin multi-component fibers such as to leave an axial hole or in any case a weakened axial portion.

[0028]. As shown in figure 1B, once a layer of splittable multi-component polymer fibers has been laid through the special spinneret 5 onto a conveyor belt S such as to create a first layer of spun-bonded non-woven fabric T_1, one layer of absorbent material T_3 such as cellulose pulp is laid on said layer of non-woven fabric.

[0029]. Subsequently, a second layer T_2 of non-woven fabric substantially identical to that prepared previously is laid on the layer of cellulose pulp T_3, as represented in figure 1B by the station identified with reference number 7.

[0030]. At this point, the fibers are subject to hydro-entangling at the hydro-entangling station 8. This treatment, widely known per se, advantageously enables to split the polymer fibers that compose the outer layers of non-woven in micro-fibers and to entangle them with one another and with the cellulose pulp fibers.

[0031]. Preferably, the hydro-entangling is made not only on side S_1 of the support S on which the fibers are laid but also on side S_2, opposite side S_1, through special through holes (not shown in the figures) and suitable equipment positioned on said side S_2 (not shown).

[0032]. Figures 1B and 1C also schematically represent a conventional filtering device 20 for the water originating from the hydro-entangling machines positioned after the cellulose pulp laying step. Said device has the function of recovering the water of the hydro-entangling machine and filtering it of any cellulose pulp fibers.

[0033]. Figure 3 shows the splittable multi-component polymer fiber before (3a) and after(3b) the hydro-entangling treatment.

[0034]. Further examples of splittable multi-component fibers are described in patent applications US-A-5970583, DE-A-19846857 and WO 00/20178, incorporated herein for reference.

[0035]. It is understood that with this treatment the free spaces between the polymer fibers laid on the conveyor belt are considerably reduced. Therefore, there is less cellulose pulp loss during hydro-entangling. It results that a greater amount of cellulose pulp may be withheld in the final multi-layer product with a resulting considerable increase in the absorbent power and softness and with advantages of reduction of cellulose pulp loss in the abovementioned filtering system.

2. Production of exploded synthetic polymer fibers

[0036]. The process for the production of non-woven based on exploded polymer fibers comprises the following manufacturing steps:

i) preparing at least one layer (T_1) of exploded polymer fibers;

ii) hydro-entangling said at least one layer such as to obtain a non-woven fabric in which the polymer fibers are exploded into micro-fibers entangling with one another.

[0037]. Preferably, the step i) comprises:

- preparing at least one layer (T_1) of exploded polymer fibers;

- laying at least one layer of fibers of absorbent material (T_3) on said at least one layer (T_1), whereby the

hydro-entangling step ii) takes place such as to obtain a non-woven fabric in which the polymer fibers exploded into micro-fibers entangle both with one another and the fibers of the absorbent material.

[0038]. More preferably, the step i) comprises:

- preparing at least one layer (T_1) of exploded polymer fibers;
- laying on said at least one layer (T_1) at least one layer of fibers of absorbent material (T_3);
- laying at least one further layer (T_2) of exploded polymer fibers on said at least one layer of fibers of absorbent material,

whereby the hydro-entangling step ii takes place such as to obtain a multi-layer non-woven fabric in which the polymer fibers exploded into single micro-fibers entangle with one another and with the fibers of the absorbent material.

[0039]. According to Nanoval technology, the explosion of the fiber (just extruded at the molten state) is obtained when it comes into contact with air at room temperature.

[0040]. Generally, as described in patent application WO 02/052070, Nanoval technology consists in producing molten polymer threads protruding from spinning holes arranged in one or more rows placed in a chamber with a

given pressure value separated from the outside environment and filled with gas, generally air. Said threads come to an area of rapid acceleration of this gas when exiting from the camera, the outlet being made in the form of a Laval nozzle.

[0041]. The forces that are transmitted to the respective threads along the route, following tangential stress, increase, while the diameter of the threads drops strongly and the pressure in their still fluid inner portion increases intensely in an inversely proportionate manner to the effect of surface stress. Following the acceleration of the gas, pressure drops according to hydrodynamic laws. Besides, the temperature conditions of the molten mass, the gas flow and the rapid acceleration thereof adapt with one another, so that the thread before being cured reaches an inner hydrostatic pressure which is greater than the pressure outside the chamber, whereby the thread explodes into a plurality of micro-fibers or fine filaments. Through a slit in the bottom of the chamber, both the threads and the air can be released from the chamber.

[0042]. The raw materials that can be spun are both of natural origin, such as cellulose Lyocell, PLA, and synthetic or such as polypropylene, polyethylene, polyamide, polyester.

[0043]. Alternatively, the spinning mass is forced through a elongated nozzle in the form of a slit into a chamber separated from the environment with a given pressure, as above, into which gas, for example air, is introduced. The film that is released from said nozzle reaches an area of rapid acceleration of the gas released from said camera. Below the acceleration area, i.e. in the stress release area, the film explodes and substantially endless micro-fibers or filaments are obtained. In any case, unlike those formed by single threads, they have very different diameters and thickenings in the shape of knots.

[0044]. Preferably, the Laval nozzle is cylindrical and elongated with a convergent edge so that the transversal section thereof is narrow upstream and then rapidly widens downstream. In the narrowest portion, by selecting the pressure value in the chamber (in the case of air about twice environmental pressure), flow speeds near to those of sound are obtained whereas in the wider part of the Laval nozzle speeds are higher than those of sound.

[0045]. It is understood that a man skilled in the art will be able to set the working parameters for example, the flow rate of the polymer melted in the spinneret, the temperature inside said spinneret and the gas flow rate in order to adapt them to the type of polymer used and to

the specific requirements for obtaining diameters of the individual micro-fibers or filaments.

[0046]. With regards to the laying of the exploded fibers to form a first layer and the further manufacturing steps, the same references are valid as made to figures 1A, 1B and 1C in which the suction fan A is eliminated and the spinnerets 5, 7, 11, 15 are each fitted with the abovementioned Laval nozzle (not shown) in order to obtain the explosion effect.

[0047]. The advantage of use of the Nanoval technology lies in the possibility of producing very fine micro-fibers with diameters of less than 10 μm, for example between 2 and 5 μm in a simple and cost effective way without the aid of jets of gas (air) heated beyond the polymer's melting point, as occurs for example with meltblown technology. Besides, the micro-fibers are not damaged in their molecular structure by the use of high temperatures. Accordingly, the end product has greater resistance and therefore shows slower wear over time.

[0048]. A further advantage also in relation to the technology that employs splittable polymer fibers lies in the fact that a greater density of individual micro-fibers per each fiber is obtained. In other words the fiber divides into a number of components with equal initial diameters, i.e. the micro-fibers (filaments) that

are obtained are at least 10 times finer, preferably up to 100 times finer.

[0049]. Regardless of the type of splittable or exploded fiber used, if it is desired to pre-hydro-entangle the non-woven before bonding it into the form of a multi-layer composite (figure 1C), the steps are as follows: laying the first layer T_1 by means of the spinneret 11, pre-hydro-entangling through equipment 12, drying through equipment 13, laying cellulose pulp T_3 through equipment 14, laying the second layer T_2 through spinneret 15, hydro-entangling with hydro-entangling machine 16, drying through equipment 17 and rewinding onto a roller 18. The production process and system may also provide a dewatering step or station 19 associated to the drying step or station. The advantage of a pre-hydro-entangling step is that it allows to create a first layer of split or exploded polymer fibers that, thanks to the greater density of the entangling of the micro-fibers of said fiber, helps to lay fibers of absorbent material and prevents the partial loss thereof through spaces too wide, which are left by prior art technologies.

[0050]. As mentioned previously, the step of laying fibers of absorbent material is preferably made with cellulose pulp fibers having a length that may vary from 0, i.e. cellulose powder, to 2.5 mm, preferably from 1 to

2 mm.

[0051]. In addition, the process according to the invention may provide a drying step after the hydro-entangling step and, preferably also after the pre-hydro-entangling step.

[0052]. A further step may consist in the elimination of the water contained in the fibers by means of a dewatering step. Particularly, said step consists in arranging a condenser 19 below support S for the non-woven fibers to which a completely conventional suction fan (not shown) is usually coupled up. The air sucked through the holes made on said support is conveyed into said condenser where it releases the water contained therein. Equipment of this type is described for example in patent application PCT/IT2004/000127 of the same applicant.

[0053]. The process may also comprise an embossing step of the multi-layer non-woven. Particularly, the embossing may consist in a calendering treatment made by making the non-woven being heated and pass under pressure between a pair of engraved rollers, in accordance with conventional techniques, or through a further step in a hydro-entangling machine. It should be noted that the term "embossing step" does not mean a consolidation of the non-woven as occurs according to the prior art mentioned

previously but simply constitutes a step enabling to make captions and/or three dimensional drawings in order to personalize or decorate the non-woven through a "thermoembossing" or "hydroembossing" calender.

[0054]. Preferably, the process comprises sucking the air at room temperature through the abovementioned through holes (non shown in the drawings) made in the support S for the fibers. In this way, the splittable or exploded polymer fibers, laid at the molten state, are cooled and cured. In the case in which exploded fibers are used a humidifier (not shown) can be arranged, which humidifies the exploded fibers immediately before laying them on the support S either to help or improve the softness of the end product.

[0055]. Even more preferably, said process may comprise one or more of the following final steps, known per se, in order to increase or add additional characteristics to the end product: coloring or finishing of a chemical nature as the anti-pilling treatment and the hydrophile treatment, antistatic treatment, improvement of flame proof properties, substantially mechanical treatments such as napping, sanforizing, emerizing.

[0056]. In addition, the non-woven may be subject to a further process of multicolor printing using the equipment described in patent application

PCT/IT2004/000127 of the same applicant. In this case, a sheet of non-woven at the end of the process described above, may be printed directly in-line following the steps of:

- providing equipment for printing of non-woven comprising a moving support for the transport of said non-woven and at least one moving print organ;
- providing said equipment with said sheet of non-woven;
- performing the printing on said non-woven under the command and control of a command and control unit, in which said command and control unit is operatively connected with said support and at least one printing organ in order to detect electrical signals originating from said support and at least one print organ, transforming said signals into numerical values representative of the state of their angular speed and torsional moment, comparing said numerical values with ratios of preset numerical values of said angular speeds and torsional moments and sending signals to said support and at least one print organ in order to correct any variation of said values that fall outside said ratios.

[0057]. Finally, the process in accordance with the present invention may comprise a step of winding the non-woven on to a roller 18.

[0058]. It must be considered that a "crimp" effect can

be advantageously obtained avoiding the use of engraved calenders or machines for mechanical "crimping", by simply laying all the fibers that compose the multilayer non-woven on a support (figure 2A and 2B) having a surface comprising at least one section with a substantially perpendicular profile to the vertical flow of laying of said fibers interspaced by at least one section with an inclined profile of 10°-50° in relation to said vertical flow. Obviously the profile of the support may be modified such as to create geometrical forms or figures and captions in relief as desired.

[0059]. The process of the present invention enables to obtain different types of product:

[0060]. A. single-layer fabric with basic weight of between 15 and 150 cm/m^2. The manufacturing process is such as illustrated in figure 1A. The fiber used may be either a synthetic fiber with explosion effect, as described above and obtained according to the Nanoval technology, or it may be a bi-component (multisegments) synthetic fiber, splittable with a hydro-entangling machine, or a natural fiber with explosion (for example, Lyocell, PLA, etc.), also produced with "Nanoval".

[0061]. B. multi-layer fabric with single-layer hydro-entangling or three hydro-entangling steps with pre-hydro-entangling. The product may for example be a

three-layer multi-layer one, of which has one central cellulose pulp layer and the outer layers have different combinations of the technologies illustrated above.

I. Splittable multi-component polymer synthetic fibers

[0062]. Preferably, the splittable multi-component polymer fibers are composed of micro-fibers or filaments of polymer such as those described above with reference to the manufacturing process. The micro-fibers may have a diameter of between 0.1 dTex and 0.9 dTex and the corresponding fibers may vary according to the number of micro-fibers composing it but generally their size ranges between 1.7 dTex and 2.2 dTex. The number of micro-fibers in said fibers generally ranges between 2 and 16.

[0063]. Referring to a three-layer non-woven having an inner layer of cellulose pulp fibers and two outer layers of polymer fibers consisting of two different splittable polymer components such as polypropylene/polyethylene, analytical tests have shown the following physical characteristics:

- weight in grams per square meter ranging between 50 and 70, preferably between 55 and 65;
- tensile strength in the machine direction expressed in Newton per 5 cm (N/5cm) between 50 and 150, preferably between 60 and 120, whereas in the cross-direction between 20 and 75, it is

preferably between 30 and 65;

- elongation, calculated as a percentage of the length in a relaxed state, ranged between 35% and 85% in machine direction (MD), preferably between 45% and 75%, whereas it ranged between 70% and 100% in the cross-direction (CD), preferably between 80% and 90%;

- final content of the cellulose pulp fiber ranged between 50% and 75% of the total weight of the non-woven;

- power of absorption calculated as a percentage of total weight in relation to the weight of the dry non-woven was between 600% and 700% (according to the percentage of pulp in the end product).

II. Exploded polymer synthetic fibers

[0064]. Referring to the exploded fibers, it was observed that the micro-fibers (filaments) have a diameter ranging between 1 micron and 5 micron, preferably between 2 and 4 micron. Obviously said values may vary according to the type of preset characteristics for the end product and will depend on the production parameters selected, as described above, and in any case known to a man skilled in the art.

[0065]. As to a three-layer non-woven having one inner

layer of cellulose pulp fibers and two outer layers of polymer fibers consisting of a single exploded polymer component, analytic tests showed the following physical characteristics given in the table:

Total weight (grams)	Weight of upper layer (g/m^2)	Pulp weight (g/m^2)	Weight of lower level (g/m^2)	MD Tensile strength (N/5cm)	CD Tensile strength (N/5cm)	Thicknes s (cm)
48-65	11-13	26-39	11-13	18-27	7-14	0,40-0,65

[0066]. Regardless of the type of polymer fibers used, the final thickness of the multi-layer non-woven advantageously reaches values of up to 0.65 mm and a tensile strength of 27 N/5cm.

[0067]. It was observed that the non-wovens that are obtained by employing the technology relating to the exploded fibers advantageously enable to make a product that is softer and has a better appearance with regards to the compactness and evenness compared to a product obtained with split fibers, albeit of good quality. In addition it was noted that the filtering of the water originating from hydro-entangling is also improved, i.e. it contains fewer cellulose pulp fibers.

[0068]. The products obtained according to the present invention have a plus of resistance, softness and have a better appearance. Besides the thickness is increased

either by the explosion effect (Nanoval technology), or (splittable fibers) by the split effect, and by a technology of laying continuous thread fibers on the mat: the type of the mat (not smooth) may be as illustrated in figure 2.

[0069]. Particularly, the abovementioned characteristics result from the combination of the use of splittable multi-component polymer fibers or of exploded polymer fibers in a process of hydro-entangling to obtain a multi-layer non-woven.

[0070]. In fact as mentioned above, it was surprisingly found that despite the final structure of the non-woven being the result of a close weave of micro-fibers or fine filaments composing the polymer fibers, the hydro-entangling process is not substantially altered and, at the same time, it allows to obtain hand and functional characteristics better than any multilayer non-woven obtained with prior art technologies.

[0071]. The weave of the micro-fibers or the individual filaments of the polymer fibers allows to withhold a greater amount of cellulose pulp fibers thus increasing both the thickness of the end product and the absorbent capacity thereof. Besides it is understood that at the same time, during the hydro-entangling process the loss of cellulose pulp is generally reduced by 50% compared to

the usual technologies and, in the case of process according to the technology described in patent application WO-A-01/63032, the loss is substantially identical to the advantage of a product considerably better from the point of view of the softness, thickness and homogeneity.

[0072]. The weave of said micro-fibers also considerably increases the bonding points per surface unit so that the resistance is far greater than single- or multi-layer products in which whole fibers are hydro-entangled.

[0073]. As stated in the introductory part of this description, the drawback of the bothersome "pilling" effect is also overcome thanks to the high number of weaves between filaments, far finer than the whole fibers, the abovementioned tiny slots do not form.

[0074]. In addition, the process of the present invention advantageously allows to eliminate the lengthy and costly steps of adhesion and/or pre-treatment of the fibers according to the prior art in order to obtain a sufficiently cohesive multi-layer product.

[0075]. Below is a non-limiting example of one embodiment of the process according to the present invention.

EXAMPLE

[0076]. In an extruder a 13% cellulose solution is placed in an NMMO (N-methylmorpholin-N-oxide) aqueous solution of 75% and 12% of water in a spinning device consisting of a spinneret with a hole and a round Laval nozzle, in which the single spinning hole has a diameter of 0.5mm. The solution was introduced directly through pumps in a dosed way in a spinning device. The temperature of the Lyocell spinning mass exiting the extruder was set at 94°C. On the lower part of the tip of the nozzle and electrical resistance was applied. The elongation of the fiber filaments of the exiting fibers the nozzle was made with air at room temperature of approximately 22°C and at a pressure, measured before the acceleration in the nozzle of Laval, between 0,05 and 3 bar above atmospheric pressure. The spinning speed is about 500 m/min. The fibers exiting the spinneret undergo an explosion effect, caused by the difference of temperature and pressure between the process of extrusion and spinning and room temperature, thus opening into numerous threads that are hit by humidified air by means of a humidifier that causes moist air containing about 5% of water to pass through the extruded threads. After humidification and next to the spinneret, the threads of the exploded polypropylene fibers are sucked onto a

conveyor belt which is perforated and has its surface covered with cubical shaped ribs. The suction takes place through a fan positioned below said conveyor belt and in correspondence with the spinneret. At this point, the exploded fibers are arranged on said support in the form of a first continuous layer in amount of 11.5 g/m^2. Then, said layer is subject to hydro-entangling by means of a device sold by FLEISSNER and equipped with five sequential injectors mounted on special rollers on both surfaces of said support. Said injectors work at respective pressures of 15,50-100-100-100-150 bar and have a diameter of the injection hole from 100 to 140 microns. Subsequently, said pre-water-entangled layer passes under a cellulose pulp fiber laying station. The laying of the cellulose fibers takes place through a device sold by FLEISSNER of the "air-laid" type in which the fibers laid are fibers with a diameter of 3 micron and laid in amounts of 37.25 g/m^2. Subsequently, a further layer of exploded polypropylene fibers is laid on said layer of cellulose pulp fibers in the same way as described with reference to the first layer of exploded fibers. At this point, the three layers are interconnected through hydro-entangling by means of a device identical to that described previously and at the same conditions. At the end of the hydro-entangling

process, the thus formed three-layer non-woven passes inside a drying station in which a perforated drum receives and transports the non-woven being hit by a hot air flow of approximately 120°C. When exiting from the dryer, the non-woven is wound on a winding roller. The feeding speed of the conveyor belt along the whole non-woven manufacturing steps is maintained at approximately 500 m/min. The end product obtained has the following physical characteristics:

Total weight (grams)	Weight of upper layer (g/m^2)	Pulp weight (g/m^2)	Weight of lower layer (g/m^2)	MD Tensile strength (N/5cm)	CD Tensile strength (N/5cm)	Thicknes s (cm)
60,25	11,50	37,25	11,50	21,93	8,01	0,58

[0077]. As may be appreciated from what described above, the present patent application provides a process for the production of a multi-layer non-woven and a non-woven obtainable with said process that allows to overcome the drawbacks mentioned in the introductory part with reference to the prior art.

[0078]. Besides, a man skilled in the art may perform numerous modifications both to the process and to the non-woven all being within the scope of protection of the claims appended herein.

CLAIMS

1. A process for the production of a non-woven, comprising the following manufacturing steps;

a) preparing at least one layer (T_1) of splittable multi-component polymer fibers;

b) hydro-entangling said at least one layer such as to obtain a non-woven where the multi-component polymer fibers are split into mono-component micro-fibers entangling with one another.

2. The process according to claim 1, wherein step a) comprises:

- preparing at least one layer (T_1) of splittable multi-component polymer fibers;
- laying at least one layer of fibers of absorbent material (T_3) on said at least one layer (T_1),

whereby the hydro-entangling step b) takes place such as to obtain a non-woven where the multi-component polymer fibers which are split into mono-component micro-fibers entangle both with one another and the fibers of the absorbent material.

3. The process according to claim 1, wherein step a) comprises:

- preparing at least one layer (T_1) of splittable multi-component polymer fibers;

- laying at least one layer of fibers of absorbent material (T_3) on said at least one layer (T_1);
- laying at least one further layer (T_2) of splittable multi-component polymer fibers on said at least one layer of fibers of absorbent material,

whereby the hydro-entangling step b) takes place such as to obtain a multi-layer non-woven where the multi-component polymer fibers are split into individual mono-component micro-fibers entangling both with one another and the fibers of the absorbent material.

4. The process according to claim 1, wherein said step a) is made through separate extrusion of at least two polymers by a suitable spinneret (5,7,11,15) below which said at least two polymer components are linked such as to form a single splittable multi-component fiber.

5. The process according to claim 4, wherein said splittable multi-component fiber is obtained by spinning and subsequently linking up to 16 continuous threads of different polymers.

6. The process according to claim 1, wherein said polymer fibers derive from at least two threads of a single polymer up to 16 threads of different polymers, be they homopolymers, copolymers or mixtures thereof.

7. The process according to claim 6, wherein said polymers are selected from polyesters, polyamides, polyolefins, polyurethane, polyester modified with additives, polypropylene, polyethylene, polypropylene terephthalate, polybutylene terephthalate.

8. The process for the production of a non-woven, comprising the following manufacturing steps;

i) preparing at least one layer (T_1) of exploded polymer fibers;

ii) hydro-entangling said at least one layer such as to obtain a non-woven where the polymer fibers are exploded into micro-fibers entangling with one another.

9. The process for the production of a non-woven according to claim 8, wherein step i) comprises:

- preparing at least one layer (T_1) of exploded polymer fibers;
- laying at least one layer of fibers of absorbent material (T_3) on said at least one layer (T_1),

whereby the hydro-entangling step ii) takes place such as to obtain a non-woven fiber where the polymer fibers exploded into micro-fibers entangle both with one another and the fibers of the absorbent material.

10. The process according to claim 8, wherein step i) comprises:

- preparing at least one layer (T_1) of exploded polymer fibers;
- laying at least one layer of fibers of absorbent material (T_3) on said at least one layer (T_1);
- laying at least one further layer (T_2) of exploded polymer fibers on said at least one layer of fibers of absorbent material,

whereby the hydro-entangling step ii) takes place such as to obtain a multi-layer non-woven in which the polymer fibers exploded into individual micro-fibers entangle both with one another and the fibers of the absorbent material.

11. The process according to claim 8, wherein the exploded polymer fibers are obtained through the passage of polymer fibers through a Laval nozzle.

12. The process according to claim 8, wherein the polymers of the exploded fibers are selected from natural or synthetic polymers.

13. The process according to claim 12, wherein the natural polymers are selected from cellulose, Lyocell and PLA, whilst the synthetic polymers are selected from polypropylene, polyethylene, polyamide and polyester.

14. The process according to claim 2, wherein said laying of absorbent material fibers takes place with cellulose

pulp fibers.

15. The process according to claim 9, wherein said laying of absorbent material fibres takes place with cellulose pulp fibres.

16. The process according to claim 1, further comprising a drying step after the hydro-entangling step.

17. The process according to claim 8, further comprising a drying step after the hydro-entangling step.

18. The process according to claim 16, further comprising a step of winding the non-woven fabric onto a roller after said drying step.

19. The process according to claim 17, further comprising a step of winding the non-woven fabric onto a roller after said drying step.

20. The process according to claim 2, further comprising a pre-hydro-entangling step after said step of preparing at least one layer (T_1) of polymer fibers.

21. The process according to claim 9, further comprising a pre-hydro-entangling step after said step of preparing at least one layer (T_1) of polymer fibers.

22. The process according to claim 20, further comprising a drying step after said pre-hydro-entangling step.

23. The process according to claim 21, further comprising a drying step after said pre-hydro-entangling step.

24. The process according to claim 16, further comprising

a dewatering step simultaneous or subsequent to said drying step.

25. The process according to claim 17, further comprising a dewatering step simultaneous or subsequent to said drying step.

26. The process according to claim 18, further comprising a thickening step before the winding step.

27. The process according to claim 19, further comprising a thickening step before the winding step.

28. The process according to claim 26, wherein said thickening step takes place through calendering or hydro-entangling.

29. The process according to claim 27, wherein said thickening step takes place through calendering or hydro-entangling.

30. The process according to any of claims 1, wherein air is sucked at a temperature equal to or lower than room temperature through said polymer fibers in order to cool and cure them.

31. The process according to any of claims 8, wherein air is sucked at a temperature equal to or lower than room temperature through said polymer fibers in order to cool and cure them.

32. The process according to claim 8, wherein said exploded fibers are humidified before being hydro-

entangled.

33. The process according to claim 1, further comprising a non-woven finishing step.

34. The process according to claim 8, further comprising a non-woven finishing step.

35. The process according to claims 1, further comprising a multicolor printing step of the non-woven.

36. The process according to claims 8, further comprising a multicolor printing step of the non-woven.

37. The process according to claim 2, wherein each preparation step of the polymer fibers and laying of the fibers of absorbent material is made on a support (S) having a surface comprising sections with a profile substantially perpendicular to the vertical laying flow of the fibers interspaced by sections with an inclined profile of 10°-50° in relation to said vertical flow.

38. The process according to claim 9, wherein each preparation step of the polymer fibers and laying of the fibers of absorbent material is made on a support (S) having a surface comprising sections with a profile substantially perpendicular to the vertical laying flow of the fibers interspaced by sections with an inclined profile of 10°-50° in relation to said vertical flow.

39. A hydro-entangled single- or multi-layer non-woven which is obtainable according to the process in

accordance with claim 1.

40. A hydro-entangled single- or multi-layer non-woven which is obtainable according to the process in accordance with claim 8.

41. The non-woven fabric according to claim 39, comprising at least one micro-fiber layer.

42. The non-woven fabric according to claim 40, comprising at least one micro-fiber layer.

43. The non-woven fabric according to claim 41, wherein said micro-fibers have a diameter of between 0.1 dTex and 0.9 dTex.

44. The non-woven fabric according to claim 42, wherein said micro-fibers have a diameter of between 0.1 dTex and 0.9 dTex.

45. The non-woven according to claim 43, wherein said micro-fibers have a diameter of between 1 and 5 micron.

46. The non-woven according to claim 44, wherein said micro-fibers have a diameter of between 1 and 5 micron.

47. The non-woven according to claim 45, wherein the weight in grams per meter is between 50 and 70, the tensile strength in the machine direction expressed in Newton per 5 cm (N/5cm) is between 50 and 150, whereas in the cross-direction of between 20 and 75, the elongation calculated as a percentage in relation to the length in a relaxed state is between 35% and 85% in machine direction

(MD), whereas it is between 70% and 100% in the cross-direction (CD), the final content of the cellulose pulp fiber is between 50% and 75% by weight of the total weight of the non-woven, the absorption power calculated as a percentage of the total weight of the weight of the dry non-woven is between 600% and 700%.

48. The non-woven according to claim 46, wherein the weight in grams per meter is between 50 and 70, the tensile strength in the machine direction expressed in Newton per 5 cm (N/5cm) is between 50 and 150, whereas in the cross-direction of between 20 and 75, the elongation calculated as a percentage in relation to the length in a relaxed state is between 35% and 85% in machine direction (MD), whereas it is between 70% and 100% in the cross-direction (CD), the final content of the cellulose pulp fiber is between 50% and 75% by weight of the total weight of the non-woven, the absorption power calculated as a percentage of the total weight of the weight of the dry non-woven is between 600% and 700%.

49. The non-woven according to claim 45, wherein said non-woven is of a three-layer type having a total weight in grams of between 48 and 65, a weight of the upper layer in grams per square meter of between 11 and 13, a weight of the inner layer of cellulose pulp fiber of between 26 and 39 grams per square meter, a weight of the

lower layer in grams per square meter of between 11 and 13, a MD tensile strength of between 18 and 27 N/5cm, a CD tensile strength of between 7 and 14 N/5cm and a thickness of between 0.40 and 0.65 mm.

49. The non-woven according to claim 46, wherein said non-woven is of a three-layer type having a total weight in grams of between 48 and 65, a weight of the upper layer in grams per square meter of between 11 and 13, a weight of the inner layer of cellulose pulp fiber of between 26 and 39 grams per square meter, a weight of the lower layer in grams per square meter of between 11 and 13, a MD tensile strength of between 18 and 27 N/5cm, a CD tensile strength of between 7 and 14 N/5cm and a thickness of between 0.40 and 0.65 mm.

50. Use of splittable or exploded multi-component polymer fibers for the production of a single- or multi-layer non-woven.

51. The use according to claim 50, wherein said multi-layer non-woven comprises one layer of absorbent material fibers between two layers of split or exploded multi-component polymer fibers.

"NON-WOVEN BASED ON EXPLODED OR SPLITTABLE MULTI-COMPONENT FIBERS"

ABSTRACT

A hydro-entangled non-woven based on multi-component fibers, either exploded or splittable by hydro-entangling, and a process for the obtaining of the same is described: the thus obtained non-woven has improved softness, resistance and appearance and increases the productive potential of a future industrial line.

[Figure 1C]